National Bureau of Standards
Basic Instrumentation Section
Electronic Instrumentation Division
Washington, D. C. 20234

Progress Report: May 1 to July 31, 1966

Project Title: Telemetering Transducers

NASA Contract: R-09-022-043, Amendment #1

Accomplishments during reporting period:

Project Activities:

1. Attempts to use the Earth's Field Dynamic Calibrator for the dynamic calibration of a servo accelerometer failed when the instrument showed evidence of instability during its static calibration. It was returned to the manufacturer for repair. A subsequent attempt using a strain gage accelerometer failed due to excessive noise generated by the ball bearings of the calibrator. Teflon sleeve bearings were substituted in an attempt to eliminate bearing noise. Some preliminary test results indicated only partial success. The device appears to be sensitive to very small amounts of dynamic unbalance. Experimental studies will continue.

2. "Air Bag" isolation mounts were installed under the new electromagnetic shaker system.

3. Life cycling of pressure transducers is continuing. Nine pressure transducers of various makes, ranges and transduction principles have been or are being tested in order to collect data for a summary report.

4. An investigation was conducted into the use of Ytterbium as a thin film pressure sensor. It is summarized below:

NBS Report 8837 dated June 30, 1965 contains the information that Ytterbium is two orders of magnitude more pressure sensative than Manganin i.e.:

	Pressure Coef. of Resistance psi^{-1}
Manganin	$+ 1.6 \times 10^{-7}$
Ytterbium	$- 3.2 \times 10^{-5}$

The report suggested a possibility of using Ytterbium wire as the active arms of a pressure sensative bridge with an excitation voltage of 10 to 15 volts with an output of 100 to 200 μ volts/psi or 10 millivolts per 100 psi. Assuming a resistance of 1000 ohms this requires currents of 10 milliamps which seemed reasonable.

The Ytterbium was bought from the Research Chemical Division of Nuclear Corporation of America, Phoenix, Arizona. It was 99.9% pure in the form of a solid rod 1 3/8" x 3" long. All attempts to roll or draw pure Ytterbium wire failed. The metal although soft becomes brittle, work hardens easily and then fails in tension when it is not cold welding to the rollers.

A second series of attempts were made to use Ytterbium as a form of pressure sensitive foil by vacuum deposition on a glass substrate with tabs of Nickel for contacts. Although it was possible to deposit thin films of Ytterbium with resistances of 1000Ω to 10,000Ω the resistance values did not remain constant. The Ytterbium seems very active at room temperatures and turns black from oxidation within a short time. The resistance of the film showed a continuous change with time until it reached values in megaohm regions.

The foil was very sensitive to self heating which in turn altered the resistance. It turned out that the coef. of resistance with temperature was $13 \times 10^{-4}/^{o}C$ and in order to avoid self heating effects, currents of microamp were used. The tests indicated that the Ytterbium oxides would break down at milli voltages with milli amps of current.

The standard tests did not give sensitivities resembling any of the data reported, but far more important, the material tended to alter with pressure work hardening. It did not return to the same zero. A form of hysteresis was evident which prevented one from being able to assume a knowledge of the true resistance since it seemed a function of the past history of the film.

Thus for optimum stability and reliability one must first determine a technique that allows establishment of a uniform pure non oxidized film.

At the present time the problem seems to be one of preventing physical and mechanical changes from altering the value of the resistance after the pressures are relieved.

None of the tests made on the thin film Ytterbium agreed with bulk measurements. One supposes this is proof of the lack of puriety and stability in the coarse films that were prepared. Although it is reported to have a corrosion rate of less then $0.2 mg/dm^2/day$ at $35^{o}C$ in practice this seems to be a real problem since, judging from resistance measurements, unlike the lighter metals, the oxidation continues through the material until little or no pure foil remains.

Future Activities

1. Experimental studies will continue on the Earth's Field Dynamic Calibrator in order to try to eliminate sources of noise and instability which affect the wave shape of the generated acceleration.

2. A summary report will be started dealing with the "Life Cycling" program on pressure transducers.

3. A study will continue of "methods of dynamically determining amplitudes of small displacements". This will provide the basis for the experimental work of generating low level dynamic accelerations by means of the new electromagnetic vibrator.

4. It appears likely that this laboratory will move into the new facility of NBS at Gaithersburg, Maryland during the next quarterly period. This will result in some unavoidable delays in the program.